bodies present upon which the crystals may form.

It seems probable that in these facts we have an explanation of the influence which vegetation appears to have upon the deposit of silicious material in the pools of the geyser basins. The mere presence of the algal filaments as foreign bodies encourages the deposition of silica, and it naturally follows that the greatest amount of silica is thrown down where the vegetation is thickest. This gives us the entire secret of the peculiarities of columns and mouldings. As has been before described, it is the habit of algæ in quiet water to grow up in tufts. A tuft once established leads to the deposition of more silica at that particular spot, and soon there will be formed a little mound or cone, capped and covered by a mass of filament. The algal filaments always tend to grow upward in quiet water, if for no other reason because of the numerous bubbles of oxygen thrown off, which, becoming entangled in the threads, tend to buoy them up. As the algal cap on top of a cone grows upward, more silica is laid down at its base, and so a column of deposit gradually rises. When the cap of vegetation reaches the surface of the water, there is, after the habit of such forms, an immediate radiation of the filaments in all directions. Consequently, when the final deposit of silica is left upon the top of the column, it extends on all sides as an overhanging capital. As the shaft of the pillar is covered with the sheet of vegetation, we can readily understand why it should thicken and why there might be irregular protuberances or even smaller columns rising at different levels along the sides of the larger. Of course, the algal growth will not be uniform on all sides of the pillars, any spot that is especially vigorous leaving a record for itself through a larger amount of mineral deposit.

Much more must be known about the exact conditions of growth in these thermal waters, before the many peculiarities of the mineral deposits are explained. But a new interest is added to the hot springs of Yellowstone Park and their deposits when one thinks of the parts these simple organisms play in the construction.

Children of steam and scalded rock, a story you have to tell,
Writ in the glare of sunshine bright,
Sculptured and etched in marble white,
Illuminated in colors bold,
Richer than ever parchment old,
Children of steam and scalded rock, what is the story you have to tell?

Our legends are old, of greater age than the mountains round about.
We have kept our secrets epochs long,
They are not to be read by the passing throng.
It is nothing to us what men may say.
If they wish our story the price they must pay
In hard brain work, ere the tales are told. We challenge mankind to draw them out.

Children of steam and scalded rock, your challenge must rest for the present age.
I have scarcely broken the outer crust
That covers the greater truth, but I trust
Some man will follow and therein find
Knowledge, that to the Present shall bind
The Past with cords wherein entwine
Threads of the perfect truth, divine.
Children of steam and scalded rock, some man to come will accept thy gage.

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RAREFIED AND CONDENSED AIR.

AFTER reading Paul Guessfeldt's enthusiastic description of 'mountain-ecstasy,' as he calls it, which the rarefied air of high altitudes produces and which he describes as consisting of 'an increased sense of joy caused by an increased muscular activity, and a wonderful buoyancy of the feelings which at moments rises to ecstasy,' we are tempted to follow him to those heights in order to experience these feelings which can be so easily obtained with a little physical exertion.

A different point of view is presented to us by D'Orbigny (1826) in an account of the sensations he experienced while crossing the highest pass of the Cordillera in Bolivia, which is 4,500 meters (about 15,600 ft.) high, on his way from the coast of Peru to La Paz. For several days before reaching the highest part respiration was difficult. His driver, the mule he was riding and his dog suffered so much that they were compelled to halt every 20 or 30 meters to regain their breath. While crossing the crest of the ridge he suffered intensely from pains in the temples, vertigo, and extreme difficulty in breathing. Every movement of the body produced palpitation of the heart, followed by a feeling of general debility, until bleeding of the nose finally relieved him. During this attack of 'mountain-sickness' he saw two natives, who had overtaken him, hurry on their way, climbing the rocks with the greatest ease.

It is evident that D'Orbigny did not belong to an Alpine club, and did not have the necessary training, or else he would not have suffered so intensely at an altitude which has no effect upon those who now ascend Mount Blanc.

A man who has had no practice in mountain climbing is apt to experience sensations similar to those which D'Orbigny described, while yet under the ordinary atmospheric pressure. For instance, in hurrying up a steep incline, say in the winter, when you sink into the snow with every step, you will very likely become short of breath, since the rapid climb prevents the full expansion of the lungs. This disturbs the circulation of the blood, which, being no longer freely admitted into the contracted lungs, collects in the veins. They swell up, the face becomes purple, the pulse-beats are accelerated, and palpitation of the heart sets in. In case the exertion is continued, an attack of nausea is imminent, together with a feeling of faintness in the lower limbs, as the overworked muscles are deprived of their requisite supply of oxygen. A few long drawn breaths usually suffice to remedy the disorder. By gradually becoming accustomed to walking and breathing slowly and regularly a further attack is prevented.

These symptoms, as they manifest themselves in the rarefied air of high altitudes, constitute what is known as mountain-sickness, and persons unaccustomed to mountain-climbing are frequently affected by it even while resting or when not exerting themselves. Here, again, the cause of the disorder is the insufficient expansion of the lungs, caused by the diminished atmospheric pressure which renders respiration difficult.

But, it may be objected that the energy with which we inhale the air is the same at high altitudes as below, and the rarefied air ought to penetrate into the lungs more easily. This is perhaps true, but, although we expand the chest during inhalation, the expansion of the lungs is only accomplished by means of the atmospheric pressure. The lungs are not attached to the inner surfaces of the thorax and can move freely. A wound in the thorax which admits the passage of air causes the lungs to contract, and all the exertions of the breathing apparatus will be powerless toward relieving this contraction.

As long, however, as the cavity of the chest remains closed and contains no air, the pressure of the air in the lungs acts from within outwardly and by expanding the lungs will cause them to remain in contact with the sides of the chest as it expands during the process of inhalation. The ease with which the lungs are expanded depends upon the amount of atmospheric pressure which is brought to bear upon their elastic power of resistance, and this action consequently becomes more difficult as the lighter pressure of higher altitudes is reached. Let

us suppose that the usual pressure is reduced to one-half, then the rapidity with which the lungs are expanded, although still greater than the usual rate of the chest expansion, is yet only half as rapid as when under the customary atmospheric pressure, and under certain circumstances this may seriously disturb inhalation.

Exhalation, on the contrary, is accelerated by the lighter pressure of a rarefied atmosphere. It generally takes place without the aid of the muscles which assist in the process of inhalation. The expanded parts, as the lungs, diaphragm, etc., contract to their original size and position by reason of their elasticity, as soon as the muscular force which was applied during inhalation is relaxed. The employment of the abdominal and intercostal muscles as an aid to exhalation is exceptional.

The only obstacle which retards the contraction of the lungs is the pressure of the outer air, which resists the outflow of the air from the windpipe and is diminished as the atmosphere becomes rarefied. Consequently the contraction of the lungs is greater and more rapid in a rarefied atmosphere. Exhalation is, therefore, in general, a mechanical process, and as such is subject to a certain law acording to which it can be performed on the summit of Mount Blanc in $\frac{8}{10}$ of the time required under the ordinary atmospheric pressure.

Humboldt tells us that newcomers in the vicinity of Quito, Ecuador, where the altitude is between 2,600 and 3,600 meters (11,800 ft.), have considerable difficulty in breathing, especially when talking rapidly. This is explained by the fact that the supply of breath usually reserved for the formation of sound escapes more rapidly and is therefore sooner expended. It has also been observed that some persons are unable to whistle where the pressure has only been diminished from 760 mm. (ordinary atmospheric pressure) to 500 mm. The whistling sound is produced by placing the lips in a certain position, and depends upon the rapidity with which the air is forced out of the lungs by means of the abdominal muscles. Naturally, the amount of muscular force so expended is still suited to the requirements of the denser air to which one has been accustomed. As the atmospheric pressure is diminished, the air escapes more rapidly and the expected sound is not formed. In order to learn again how to whistle, it is necessary to place the lips in another position and to apply the muscular force differently, which always requires considerable time and practice.

Physicians who have made a short stay at Davos, which lies at an altitude of only 1,600 meters (5,200 feet), state that during that time their respiration was much accelerated, while there was an inability to breathe deeply. The explanation of this phenomenon is the diminished atmospheric pressure which also causes an acceleration of the pulse-beats—the inevitable result of insufficient lung-expansion. Accelerated breathing at high altitudes affects metabolism by aiding in the removal of gaseous excretions, such as carbon dioxide.

Aëronauts observed the acceleration of the pulse to be the first physiological change. They can reach a much higher altitude than mountain climbers without having any difficulty in sustaining respiration, as their muscular exertion is not so great. But the transition to the rarefied air is more sudden, and the increased, difficulty in breathing, which now appears although the aëronaut is generally unconscious of it at first, results from an insufficient expansion of the respiratory organs, which renders them incapable of admitting the requisite amount of rarefied oxygen. The strength of his respiratory muscles is diminished; he finally loses control of his limbs, and his senses are dulled. This

was the experience of Eroce Spinelli, Sivel and Tissandier, who, on August 15, 1875, reached an altitude of 7,000 m. (23,750 ft.) with an atmospheric pressure of only 300 mm. in two hours. They followed Paul Bert's advice and inhaled oxygenated air, as a result of which their strength immediately revived.

After a longer sojourn in regions of high altitude the symptoms of mountain-sickness pass away, as respiration is gradually regulated to suit the conditions of the rarefied atmosphere. The change which this necessitates is easily explained. In order to breathe deeply it is necessary to expand the lungs more slowly, and this is only accomplished by means of continuous unconscious practice which strengthens the respiratory muscles. The members of Alpine clubs who make high ascents keep in practice by repeating their excursions frequently. Hence they are far less subject to mountain-sickness than those who have had no previous training.

The wonderful feats of Paul Guessfeldt, which are described in the German Rundschau of 1892, are a good illustration of the benefits to be derived from such a training. He breathed and moved without any inconvenience at an altitude of about 5,500 meters, where the atmospheric pressure is equal to only one-half of the ordinary pressure. In ascending Mt. Aconcagua, in Chile, he had no difficulty in breathing until after the altitude of 6,000 meters had been reached, and even then he was finally able to ascend to the summit, which has an elevation of nearly 7,000 meters, or 23,910 ft., an altitude at which aëronauts are compelled to have recourse to their supply of oxygenated air.

A distinguishing characteristic of the air of high altitudes as compared with that of lower regions is its freedom from moisture. The atmosphere is so dry on the plateaus of the Andes in Peru and Bolivia, where the altitude ranges from 3,600 to 3,900 meters, that the flesh of butchered cattle can be dried in the open air. The two explorers, D'Orbigny and Wedell, both report that the sheep which are killed there are split open and salted, after which they are hung up in the open air, and are dried in four or six days.

The ocean is the chief source of the moisture contained in the atmosphere; consequently the interior of the continents is drier than the coast regions, and in the same way the moisture decreases as we rise above sea level. The lower stratum of air up to about 2,000 meters (6,500 ft.) contains one-half of the whole amount of aqueous vapor in the atmosphere, and here the cloud-formations are densest and most frequent, while above this altitude the sky is much clearer.

It is a well-known fact that extreme dryness of the atmosphere stimulates the nervous system, making one feel brighter and more inclined for both physical and mental activity. The inhabitants of very dry regions, according to the reports of explorers, are free from any tendency to obesity.

In trying to escape from the hot air of the cities in the summer we look for a place which is situated higher above sea level, because we know it to be cooler. In the torrid zone, resorts with an elevation of from 2,000 to 3,000 m. are popular. In spite of being nearer to the sun, the air is cooler, as the sun's rays have practically no effect upon it. The air allows the rays to pass through it freely, but receives its warmth from the dark heat rays which are reflected from the earth after the sun has warmed it. The lower strata of air are, therefore, always warmer than the upper. But the plateaus of the highlands are cooler too, as well as the summits and crests, for their rarefied atmosphere is incapable of absorbing as much of the heat reflected by the earth as the denser atmosphere of the

lowlands. Although the surface of the earth receives more heat at high elevations, it is immediately reflected back into space without heating the air to a corresponding degree. This is evidenced by the fact that at high altitudes the difference of the temperature in the sun and in the shade is greater than in the lowlands. But the effect of the sun's rays is felt more keenly at a high elevation, so much so that persons staying at Davos can enjoy a sun-bath in a sheltered spot even in the cold of winter, although wearing much thinner clothing than at home.

It takes a visitor at Cerro de Pasco, in Peru, which lies at an elevation of 4,500 meters, ten or twelve days to thoroughly regulate his respiration to the conditions of the atmosphere. In case his suffering is greater at first, it often happens that he is compelled to make a temporary change of residence to a point some 1,000 meters nearer the level of the sea. Even during the descent he begins to breathe more easily and feels brighter and stronger.

The inhalation of air which has been artificially condensed, as in a pneumatic cabinet, produces quite similar sensations. An asthmatic patient placed in an atmosphere where the pressure has been augmented by nearly one-half will immediately be enabled to breathe more freely; respiration becomes slower; his excited nerves are quieted, and he feels imbued with renewed vigor.

The mechanical action of condensed air as it affects respiration is the reverse of the action which takes place in rarefied air. A higher atmospheric pressure facilitates the expansion of the lungs, and the condensed atmosphere, by delaying the egress of the air expelled during exhalation, finally effectuates a distended condition of the lungs. The pulse-beats become slower at the same time, and the veins, which were surcharged with blood under a diminished pressure, are now emptied more thoroughly. This is the cause of the decrease of congestive conditions in a pneumatic cabinet. The amount of oxygen which we inhale is increased in proportion to the increased condensation of the atmosphere, thereby enriching the blood. If the treatment is continued, this soon makes itself manifest by an increased appetite and a healthier complexion. The invalid gains in strength and vitality. Respiration is facilitated even outside of the cabinet, and by such observations we perceive that the employment of condensed air has after-effects, which supposition the spirometer confirms. A deeper and more quiet respiration has been observed in some cases after the elapse of one and even two years.

The air which is admitted into the pneumatic cabinets by means of air pumps can be kept at any degree of condensation. The cabinets, which are of various sizes, are arranged to admit from three to fourteen persons, and naturally great care is taken to have a good ventilation. They generally stand in the center of a lighted hall; their walls are composed of sheet iron and provided with windows which admit ample light for reading. The cabinets are used exclusively for the cure of catarrhal diseases, to facilitate the respiration of asthmatic patients, and to improve the condition of the blood of anæmic persons, in which cases the condensed air frequently proves beneficial after all other remedies have failed.

The first pneumatic cabinet was established somewhere in the thirties, at Montpellier, by a physicist named Tabarie, who later gave the management of it into the hands of a physician. Pravaz soon followed his example at Lyons, and the reports of the two scientists as to their observations made on healthy and diseased persons were presented before the French Academy and to the medical world in quick succession.

About thirty years later the idea of putting condensed air to this use spread from France to other countries of Europe, and the largest institution of this kind at present is at Reichenhall, the property of E. Mack, in which 53 persons can make use of the heightened pressure at the same time.

In 1841 M. Triger, a civil engineer, introduced in France the idea of using a heightened atmospheric pressure in building sub-aqueous works, and this gave an opportunity to observe what effect an atmospheric pressure which was much higher than that of a pneumatic cabinet would have upon the workmen. The work under pressure is carried on in an iron shaft, the sides and top of which are air-tight. It is sunk to the bottom, like a diving-bell, while the upper end protrudes above the surface of the water. The fresh air which is continuously pumped in from above expels the water below, leaving the bottom free to be worked upon. The shaft sinks deeper and deeper as the earth is removed, until there may be a pressure of $3\frac{1}{2}$ or nearly 4 atmospheres. A pressure of ten meters of water is equal to about one atmospheric pressure.

The effect of the condensed air upon the laborers was found to be surprisingly favorable up to a pressure of two atmospheres. The hard work was accomplished more easily and with less fatigue than in the open air, and in such exertions as running up a ladder they did not get out of breath. Even after working hours the men felt stronger and in better spirits.

But when the pressure exceeds that of two atmospheres the men begin to have certain unpleasant sensations, such as itching and pains and swelling of those muscles which are strained the most. These symptoms do not, however, appear while under the heightened pressure, but make themselves felt during the time that the men are under the normal pressure, and pass away again as they return to their work. The overseers are exempt from these effects. They receive instead a mental stimulus which is manifested by an increased impulse to talk.

If the atmospheric pressure is still further increased, the resistance against exhalation becomes stronger. The action of the respiratory apparatus is weakened by the increased distension of the lungs until it finally becomes almost imperceptible; speech is difficult, and whistling impossible. The result of the too rapid contraction of the lungs under a diminished pressure which prevents whistling is the same as that which follows when the egress of the air expelled by the lungs is delayed.

The enlivening influence on the workmen is diminished as soon as the pressure exceeds that of three atmospheres. The slow and imperfect performance of the respiratory function begins to have a detrimental effect upon the gaseous interchange which takes place in the lungs by causing the carbon dioxide to be retained in the blood. The laborers become more easily fatigued, and a decrease of appetite is followed by loss of flesh, if they continue the work. We find, therefore, that there is a limit to the condensation of air which a man cannot overstep without detriment to himself, but there is a wider limit in this direction than in that of rarefied air.

Experience proves that a temporary change from the normal pressure to an increased or diminished pressure is pleasant and also benefits vitality in various ways. We are able to ascend to any altitude at which the air is rarefied to the desired degree, but the privilege of choosing a denser atmosphere in which to live is denied us. It is only from a few places at very high elevations that convalescents can be sent down to a lower altitude where they quickly recover by inhaling air which is more condensed and contains a larger proportion of oxygen. The inhabitants of the

lowlands are confined to the pneumatic cabinet in their search for these benefits. From what has been said regarding the mechanical change which respiration undergoes we gather that a temporary employment of condensed air, besides its various other effects, would be a good preparation for the proper performance of the respiratory function in a more rarefied atmosphere.*

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NOTES ON THE NATURAL HISTORY OF THE WILMINGTON REGION.

A BRIEF collecting trip to the vicinity of Wilmington, N. C., made about the middle of April, greatly impressed me with the natural history advantages of the region. I publish these few notes in the hope that they may be of service to other naturalists who think of visiting the Southern coast.

In Wilmington itself no one can fail to notice the admirable shade tree, the laurel oak (*Quercus laurifolia* Michx.), so common along the streets. This tree in Wilmington passes under the name of water oak; in South Carolina it is known as the Darlington oak. Its straight bole, symmetrical top and moderate size give it an elegance of shape well suited to city streets, and the impression of finish is heightened by the glossy aspect of the foliage.

From the city there runs a most excellent road, eight miles long, to Wrightsville, a settlement on the coast. The road is a well-kept shell road, smooth, hard, and good for bicycling. Scrub oaks, elms, long-leaf pines and cypresses edge it, and near the sound the full green heads of the live oaks are seen on all sides. In the open meadow-like places (savannahs) to the right and left of the road there grow in great abundance insectivorous plants, the most interesting members, to the general biologist at least, of that rich Wilmington flora made known through the labors of Curtis, Wood and other systematic botanists. The yellow-flowered pitcher plant, *Sarracenia flava*, dots the savannahs in all directions; its great flower (four inches wide) upheld by a scape one to two feet, making it a conspicuous object. The fly-trap, *Dionœa*, and sun-dew, *Drosera*, neither in flower at the time of my visit, are scattered thickly about. Intermingled with these are a blue and yellow species of butterwort, *Pinguicula*, their bright flowers standing out clearly against the (at this time) brownish savannah and often leading one to patches of *Dionœa* and *Drosera*, which otherwise would have been passed by unnoticed. These five insectivorous plants may sometimes be found growing together in a little patch of ground, scarcely larger than a square foot.

The topography of the Wrightsville district is that characteristic of the Carolina coast, and in a less degree of the Southern coast in general. A sound separates the mainland from a seaward strip of land, known as the 'banks.' Wrightsville, largely made up of houses occupied only during the summer, is on the mainland. Opposite it, on the banks, is a newer summer settlement. Between the two, the sound is crossed by a railroad trestle, the piles of which afford good collecting.

The sound something less than two miles wide, is divided into a narrow outer portion, adjoining the banks and known as the banks channel, and a wider inner portion, studded with sandy-mud shoals. The banks channel is a narrow but pretty boating ground, opening out to sea through two inlets, one recently made in a heavy storm. Along the inner edge of the channel lie some islands, the 'hammocks,' wooded with live oaks, about which jackdaws (*Quiscalus major*) were flying. This bird is said to spend the winter here.

* Translated from the author's MS. by Henriette Weber, Columbus, O.